

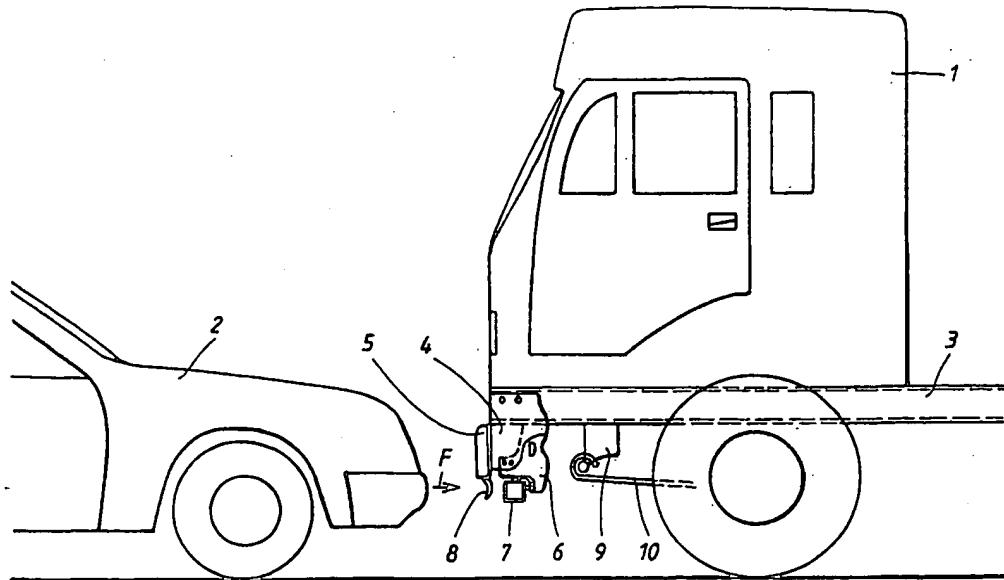
PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau

## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> :	A1	(11) International Publication Number: WO 98/41423
B60R 19/56		(43) International Publication Date: 24 September 1998 (24.09.98)
(21) International Application Number:	PCT/SE98/00473	(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).
(22) International Filing Date:	16 March 1998 (16.03.98)	
(30) Priority Data:		
9700916-1	14 March 1997 (14.03.97)	SE
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(72) Inventor; and		Published
(75) Inventor/Applicant ( <i>for US only</i> ): GOLLUNGBERG, Peter [SE/SE]; Köleröd 350, S-440 60 Skärhamn (SE).		With international search report. With amended claims. <i>In English translation (filed in Swedish).</i>
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(54) Title: DEVICE FOR UNDERRUN PROTECTION IN VEHICLES



## (57) Abstract

The invention relates to a device for underrun protection of vehicles (1), comprising a frame (3), an impact element (7) arranged on the vehicle (1) in a position which corresponds to the expected impact of a force (F) in the event of a collision, and an energy-absorbing element (6) which connects the frame (3) to the impact element (7). The invention is characterized in that said energy-absorbing element (6) is shaped with a weakened portion (14, 15), which essentially constitutes a pivoting joint for deforming bending of the element (6) during said impact. By means of the invention, an improved underrun protection is obtained which permits controlled energy absorption during impact.

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## DEVICE FOR UNDERRUN PROTECTION IN VEHICLES

## TECHNICAL FIELD OF THE INVENTION:

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The present invention relates to a device for underrun protection of vehicles, according to the preamble of appended claim 1. The invention is mainly intended to be applied in heavy cargo vehicles, in particular for preventing passenger vehicles from underrunning the cargo vehicle in the event of a head-on collision.

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## TECHNICAL BACKGROUND OF THE INVENTION:

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Large motor vehicles, for example cargo vehicles, are today built with a relatively high ground clearance. One of the major reasons for this is the need for using the vehicles on uneven surfaces. At the front of the vehicle, the ground clearance is normally in the order of size of about 40-50 cm.

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The fact that a cargo vehicle normally has a relatively high ground clearance however poses a serious risk regarding traffic safety. This is due to the fact that in the case of a head-on collision between a cargo vehicle and a passenger car, there is a risk that the front part of the passenger car will slide in under the front of the cargo vehicle and will thus be pinned down between the road and the underside of the front of the cargo vehicle. This can cause the front of the cargo vehicle to penetrate into the passenger car with a great deal of force, which in turn can cause serious injuries to those travelling in the vehicle. In unfortunate cases, the cargo vehicle can even continue forward and run over the passenger car, which of course can cause even more serious injuries.

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Various solutions have been devised in order to solve the above-mentioned problems. The cargo vehicle can be designed with a lowered front, i.e. a front where the ground

clearance is so low that there is no room for a passenger car to slide in under the cargo vehicle and be pinned down between the cargo vehicle and the road in the event of a collision. Such a solution, however, counteracts the above-mentioned desire for a high ground clearance in order to facilitate driving in uneven terrain. A lowering of the ground clearance is thus not possible for many kinds of cargo vehicles.

Another solution to these problems is to provide the cargo vehicle with a special underrun protection in the form of a reinforced structure, for example in the form of a horizontally arranged beam element in the front of the cargo vehicle. Using such an element, it is possible to prevent a passenger car from sliding in under the front of the cargo vehicle. Additionally, such a reinforced structure can be so arranged that it becomes energy-absorbing, whereby the structure absorbs energy when strained. This further decreases the risk of serious injuries in the case of a possible collision.

A particular problem in connection with energy-absorbing underrun protections is, however, that it is difficult to direct the energy absorption in a controllable manner. Another problem is due to expected legislation within the European Union, which defines threshold values for the stresses which an underrun protection must be able to withstand without exceeding a certain highest degree of deformation. According to said legislation, an underrun protection must be able to withstand up to 16 tons of pressure without being deformed. In certain kinds of accidents, there can however be pressures of considerably much higher amplitude. There is thus a need for a device for underrun protection which can withstand higher pressures than said legislative demands.

A previously known underrun protection for cargo vehicles is shown in patent document DE-C2-4103782. This underrun protection comprises a shock-absorbing element which is arranged under the front bumper of the cargo vehicle. The 5 shock-absorbing element can be arranged at a certain angle relative to the road. In the event of a collision with a passenger car, the bumper will be affected with a certain force, which will cause a link system to move the shock-absorbing element to a position which prevents the 10 passenger car from sliding in under the cargo vehicle.

Although this new design in principle provides a good protection against underrunning of the passenger car, it has a drawback in that it comprises a large amount of 15 moving parts, which makes it unnecessarily complicated, and creates a risk of degraded function. This solution additionally offers a small possibility of directing the energy absorption in a controlled manner in the event of a collision.

20 Another known underrun protection for a vehicle is shown in patent document DD 259822. This system exhibits two essentially S-shaped attenuating elements, which are deformable, and which are arranged between a spring attachment of the vehicle and an underrun protection. In 25 the event of a strain the attenuating elements are deformed, and thus absorb force.

#### SUMMARY OF THE INVENTION:

30 The object of the present invention is to provide an improved underrun protection for cargo vehicles, which provides a reliable function, and which meets the demands made on energy absorption. In particular, an object is to provide an underrun protection which provides a controlled 35 energy absorption during stress. The above-mentioned object

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is achieved by means of a device, the characteristics of which will become apparent from appended claim 1.

5 The invention is intended for vehicles which comprise a frame structure and an impact element which is arranged on the vehicle in a position which corresponds to an expected force strain in the event of a collision. The invention also comprises an energy-absorbing element which connects said frame to the impact element. The invention is based on said energy-absorbing element being shaped with a weakened part, which essentially constitutes a pivoting joint for deforming bending of the element during said strain.

10 15 According to a preferred embodiment, the energy-absorbing element is so shaped that it is only deformed during energy absorption if it is affected by a force which exceeds a predetermined threshold value. This threshold value can be chosen according to current legislation.

20 25 In a preferred embodiment, the invention comprises a counteracting element, preferably in the form of an existing spring attachment in the vehicle. In the event of deformation, the energy-absorbing element will come into contact with the spring attachment, whereby extremely large forces are absorbed. The invention can thus withstand larger forces than the planned legislation, without the risk of underrunning occurring.

30 Additional advantageous embodiments of the invention will become apparent from the appended dependent claims.

35 BRIEF DESCRIPTION OF THE DRAWINGS:  
The invention will in the following be explained more closely, with reference to an example of a preferred embodiment and the appended drawings in which:

Fig. 1 is a side view which schematically shows how the present invention can be arranged in a cargo vehicle,

5 Fig. 2 is an exploded perspective view which shows the main components according to the invention,

Fig. 3 is a side view which shows the function of the invention.

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#### PREFERRED EMBODIMENTS:

The invention constitutes an underrun protection which in particular, but not exclusively, is intended for cargo vehicles with a relatively high ground clearance. Fig. 1 is a somewhat simplified side view, which shows a cargo vehicle 1 which is provided with an arrangement according to the invention. The figure also shows a passenger car 2. From the figure, it can be seen that a possible head-on collision between a passenger car and a cargo vehicle could lead to the passenger car being pinned down between the cargo vehicle and the road, which might cause serious injuries to those travelling in the passenger car 2. One of the main objects of the present invention is to prevent such situations from arising.

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The cargo vehicle 1 is, in a conventional manner, provided with a frame which in turn comprises two longitudinal frame beams, of which only one frame beam 3 can be seen in the drawing. The frame beam 3 essentially extends in the longitudinal direction of the vehicle 1, up to its front part. In a preferred embodiment of the invention, there are two chassis consoles 4 fixedly arranged at each frame beam 3, to be more exact at the front part of each frame beam 3. The drawing, however, shows only one of the chassis consoles 4. Additionally, there is a bumper 5 arranged

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horizontally across the front part of the cargo vehicle 1. The bumper 5 is supported by the chassis consoles 4.

According to the invention, energy-absorbing means are provided in the form of two additional consoles 6 (of which only one console can be seen in Fig. 1) which are attached to both the frame beam 3 and the chassis console 4, and connects these elements to each other. The consoles 6, which will be described in more detail below, constitute an impact element in the form of a beam 7 which extends essentially horizontally across the longitudinal extension of the vehicle 1. The crossbeam 7 has an essentially square (alternatively rectangular) cross-section and is arranged at a height over the road which corresponds to a certain predetermined ground clearance, preferably about 35-40 cm. There is also a spoiler 8 fixedly arranged to the lower edge of the bumper 5. The spoiler 8 extends along the bumper 5 level with the crossbeam 7.

Each of the frame beams 3 is additionally connected to a moulded console, which constitutes a spring attachment 9 for a spring 10. In a manner which as such is previously known, this spring 10 constitutes a part of the wheel suspension of the cargo vehicle 1. The spring attachment 9 is essentially arranged in line with the energy-absorbing console 6, i.e. as seen in the longitudinal extension of the cargo vehicle 1.

As will be described in detail below, the invention functions in the following manner. In the event of a collision between the cargo vehicle 1 and the passenger car 2, the crossbeam 7 will be affected by a large force F. This force F will propagate to each of the consoles 6, which in a controlled manner can be deformed so that the force can be absorbed. At the same time, the passenger car

2 is prevented from sliding in between the cargo vehicle 1 and the road.

Fig. 2 is an exploded perspective view, which in a somewhat simplified manner shows the design of the crossbeam 7 and the energy-absorbing consoles 6. The drawing only shows one of the consoles 6 part of the crossbeam 7. Both of the consoles are however arranged in the same manner. Each of the consoles 6 is preferably manufactured from boron steel, and is arranged by means of a bolted joint in an attachment 11, close to the end 12 of the crossbeam 7. Furthermore, each console comprises an upper section 13, which preferably consists of a rigid attachment portion which is intended to be attached to each frame beam 3 (of which only one frame beam can be seen from Fig. 2) by means of a bolted joint. The high degree of rigidity of the upper section 13 is preferably obtained by hardening of this part. The attachment to the frame beam 3 is made via the above-mentioned chassis console 4, which is shaped with a cross section which essentially looks like the letter "h". During assembly, the upper part of the console 6 is moved into the chassis console 4 as shown by an arrow in Fig. 2. The console 6 and the chassis console 4 are arranged at the frame beam 3 by means of (not shown) through-going screws, which extend both through the consoles 6 and the chassis console 4.

When exposed to a force F, the crossbeam 7 will be affected so that force propagates to each of the consoles 6. If the force is sufficiently large, the consoles 6 will be deformed and bent backwards. For this purpose, the midsection of the console 6 is shaped with a waist 14, which comprises a hole 15, which constitutes a weakening at which the console 6 can be bent when exposed to a force. The lower part of each energy-absorbing console 6 is shaped

as an oblique portion 16, whose form is adjusted to each of the attachments 11 of the crossbeam 7.

It should be pointed out that Fig. 2 does not show the spring attachment 9 or the spring 10 (see Fig. 1).

Fig. 3 is a side view of the arrangement according to the invention, which illustrates the fact that the energy-absorbing console 6 is fixedly arranged at the frame beam 3 via a bolted screw 17 in the upper section 13 of the console 6. Additionally, said console 6 is connected to the chassis console 4 via a further bolted joint 18. The chassis console 4 is, in turn, also connected to the frame beam 3. In the event of a collision, the crossbeam 7 will be affected by a force F, which propagates to the energy-absorbing console 6. The console 6 is dimensioned to withstand the stresses which correspond to a pressure up to a predetermined threshold value (for example a pressure of 16 tons straight into the crossbeam 7). As has been described above, considerably much larger forces can occur in certain kinds of accidents. According to the invention, the bolted joint 18 between the console 6 and the chassis console 4 is dimensioned so that it is torn apart in case of stresses which exceed said threshold value. Furthermore, the energy-absorbing console 6 is dimensioned so that it in the event of such large forces will collapse and be deformed through bending while absorbing energy. In order for the deformation to take place in a controlled manner, the hole 15 is arranged to define a weakened part at the waist 14 of the console 6. This weakened part forms a rotational joint for the bending of the console 6. When affected by this force, each of the consoles 6 will be bent backwards in the direction of the position shown by broken lines and with reference numeral 6' in Fig. 3.

Since the upper section 13 is hardened and extremely rigid, and since the waist 14 has been given softer material properties, the consoles 6 will be deformed while absorbing energy in a very controlled manner. When affected during a possible collision, the waist 14 will bend somewhat like a hinge around the rotational joint which is formed in the area around the hole 15, while the lower part of the console 6 will be displaced rearwards in the vehicle. This controlled process is mainly obtained by manufacturing the console 6 from boron steel, and by hardening the upper section 13. This, among other things, causes a very sharp transition between the two parts of the console 6 which have different material properties after hardening. The portion of the console 6 which is hardened is shown in Fig. 3 as a shaded part 19, which extends a section downwards seen from the upper edge of the console 6. Since the console 6 is manufactured from boron steel, the boundary between the hardened part 19 and the non-hardened part of the console 6 can be made extremely sharp, in the order of size of 10 mm.

The threshold at which the console 6 will start to be deformed while absorbing energy can be set by dimensioning the console 6, especially as regards the position and size of the hole 15. When this limit is reached, a bending will thus take place, i.e. a deformation in a controlled manner while energy is absorbed.

When the console 6 and the crossbeam 7 have been moved a certain angle backwards, the rear edge 20 of the console 6 will have moved so far back that it will come into contact with the spring attachment 9 behind the console 6. The spring attachment 9 consists of a cast element which can withstand extremely large forces. In this manner, a counteracting part is defined, by means of which large forces against the crossbeam 7 can be absorbed. Practical

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experiments have shown that forces of up to 50 tons can be absorbed with this arrangement.

5 The invention thus functions approximately as an energy-absorbing "hinge" without any actual moving parts, except for the lower part of each console 6.

10 The invention is not limited to the examples of embodiments described above and in the drawings, but can be varied within the scope of the appended claims. For example, the invention can in principle also be used as an underrun protection which is arranged at the rear end part of the vehicle or along its sides. Additionally, the amount of 15 energy-absorbing consoles 6 can be one, two or more.

20 Instead of one single hole 15, two or more holes can be made in the console 6. In an alternative embodiment, a correspondingly weakened portion can be obtained by shaping the waist 14 as a portion which is considerably thinner than the rest of the console 6.

25 Instead of using an energy-absorbing console 6 with a hardened upper section 13, the console 6 can also be designed using two (or more) pieces of material with different properties and varying degrees of rigidity, which are joined to each other in a suitable manner.

30 Instead of an existing spring attachment 9, the invention can also comprise some other kind of force-absorbing counteracting part. In an alternative embodiment, such a counteracting part can also be completely omitted.

35 In a version of the invention which is suitable for certain kinds of vehicles, each of the chassis consoles 4 can in principle be omitted. In this case, the bumper 5 and the crossbeam 7 can be attached directly to the deformable

console 6. However, such a chassis console 4 can advantageously be utilized in many kinds of vehicles for attachment of, for example, the bumper and cab of the vehicle.

## CLAIMS:

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1. Device for underrun protection for vehicles (1), comprising a frame (3), an impact element (7) arranged on the vehicle (1) at a position which corresponds to the expected impact of a force (F) in the event of a collision, and an energy-absorbing element (6) which connects the frame (3) to the impact element (7),

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characterized in that said energy-absorbing element (6) is shaped with a weakened portion (14, 15) which essentially constitutes a pivoting joint for deforming bending of the element (6) during said impact.

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2. Device according to claim 1, characterized in that said weakened portion (14, 15) is shaped with dimensions which correspond to a deformation of the element (6) only in the event of impact of a force which exceeds a predetermined threshold value.

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3. Device according to claim 1 or 2, characterized in that said pivotal joint has its extension essentially across the longitudinal extension of the vehicle (1)

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4. Device according to claim 1, characterized in that said energy-absorbing element (6) consists of a console with an essentially vertical extension, and in that said weakened portion (14, 15) comprises a hole through said console.

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5. Device according to any of the previous claims, characterized in that said energy-absorbing element (6) is manufactured from boron steel.

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6. Device according to claim 5,

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characterized in that said energy-absorbing element (6) comprises a portion (13) which is hardened and arranged in said frame (3).

5      7. Device according to any of the previous claims,  
characterized in that said impact element  
(7) consists of a crossbeam which is arranged at the front  
part of the vehicle (1), with an extension essentially  
across the longitudinal extension of the vehicle (1).

10     8. Device according to any of the previous claims,  
characterized in that it comprises a  
counteracting element (9), which said energy-absorbing  
element (6) comes into contact with after a predetermined  
15     deformation.

9. Device according to claim 8,  
characterized in that said counteracting  
element (9) consists of an existing spring attachment (9)  
20     in the vehicle (1).

**AMENDED CLAIMS**

[received by the International Bureau on 13 August 1998 (13.08.98);  
original claims 1-9 replaced by new claims 1-8 (2 pages)]

- 5 1. Device for underrun protection for vehicles (1), comprising a frame (3), an impact element (7) arranged on the vehicle (1) at a position which corresponds to the expected impact of a force (F) in the event of a collision, and an energy-absorbing element (6) which connects the frame (3) to the impact element (7), wherein said energy-absorbing element (6) is shaped with a weakened portion (14, 15), characterized in that said energy-absorbing element (6) comprises an upper, hardened section (13) which is connected to the frame (3) and a lower, non-hardened section in which the impact element (7) is arranged, wherein the boundary between said upper section (13) and said lower section is positioned in the vicinity of said weakened portion (14, 15) and essentially constitutes a pivoting joint for deforming bending of the element (6) during said impact.
- 10 2. Device according to claim 1, characterized in that said weakened portion (14, 15) is shaped with dimensions which correspond to a deformation of the element (6) only in the event of impact of a force which exceeds a predetermined threshold value.
- 15 3. Device according to claim 1 or 2, characterized in that said pivotal joint has its extension essentially across the longitudinal extension of the vehicle (1)
- 20 4. Device according to claim 1, characterized in that said energy-absorbing element (6) consists of a console with an essentially vertical extension, and in that said weakened portion (14, 15) comprises a hole through said console.
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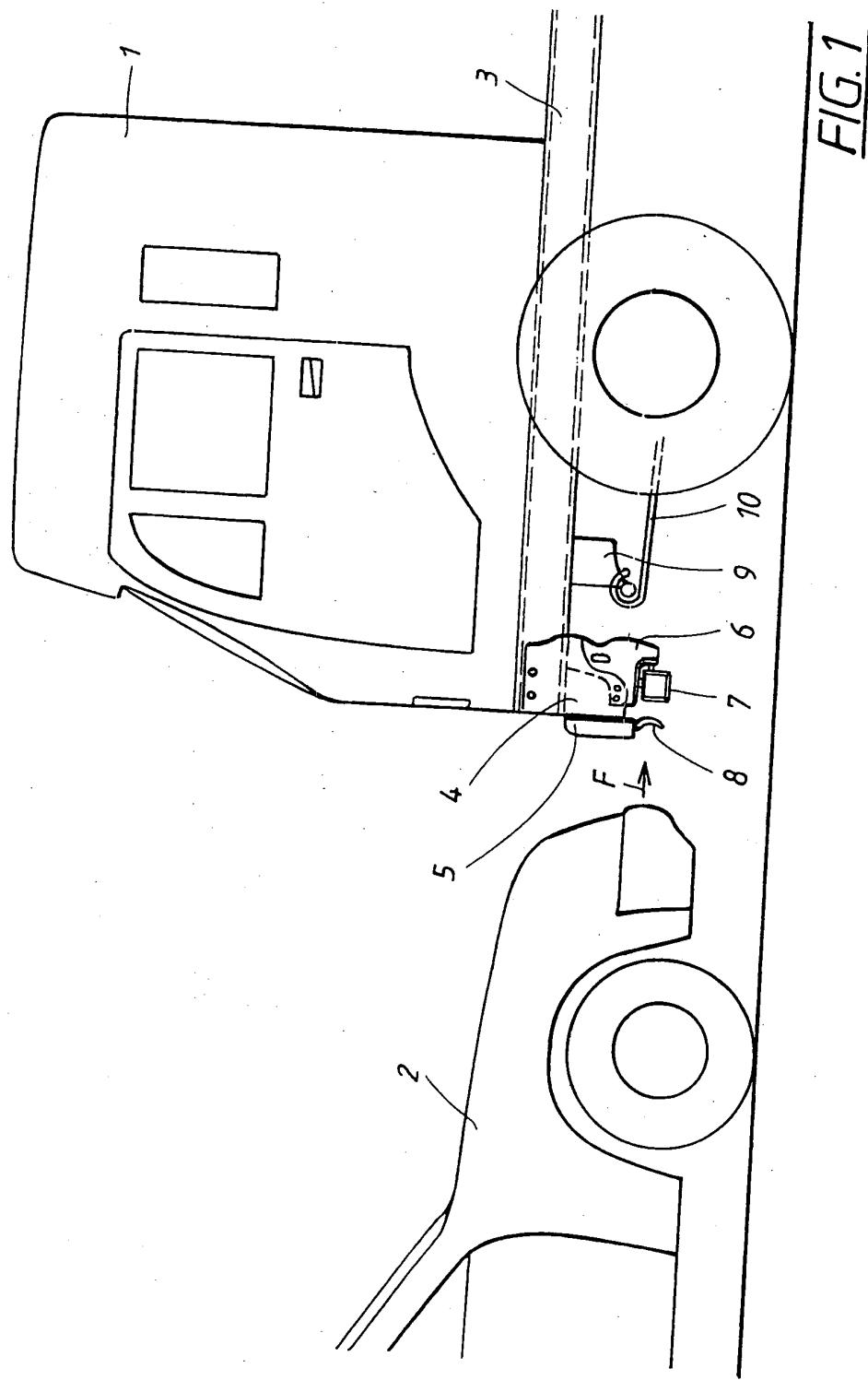
5. Device according to any of the previous claims, characterized in that said energy-absorbing element (6) is manufactured from boron steel.

5 6. Device according to any of the previous claims, characterized in that said impact element (7) consists of a crossbeam which is arranged at the front part of the vehicle (1), with an extension essentially across the longitudinal extension of the vehicle (1).

10 7. Device according to any of the previous claims, characterized in that it comprises a counteracting element (9), which said energy-absorbing element (6) comes into contact with after a predetermined deformation.

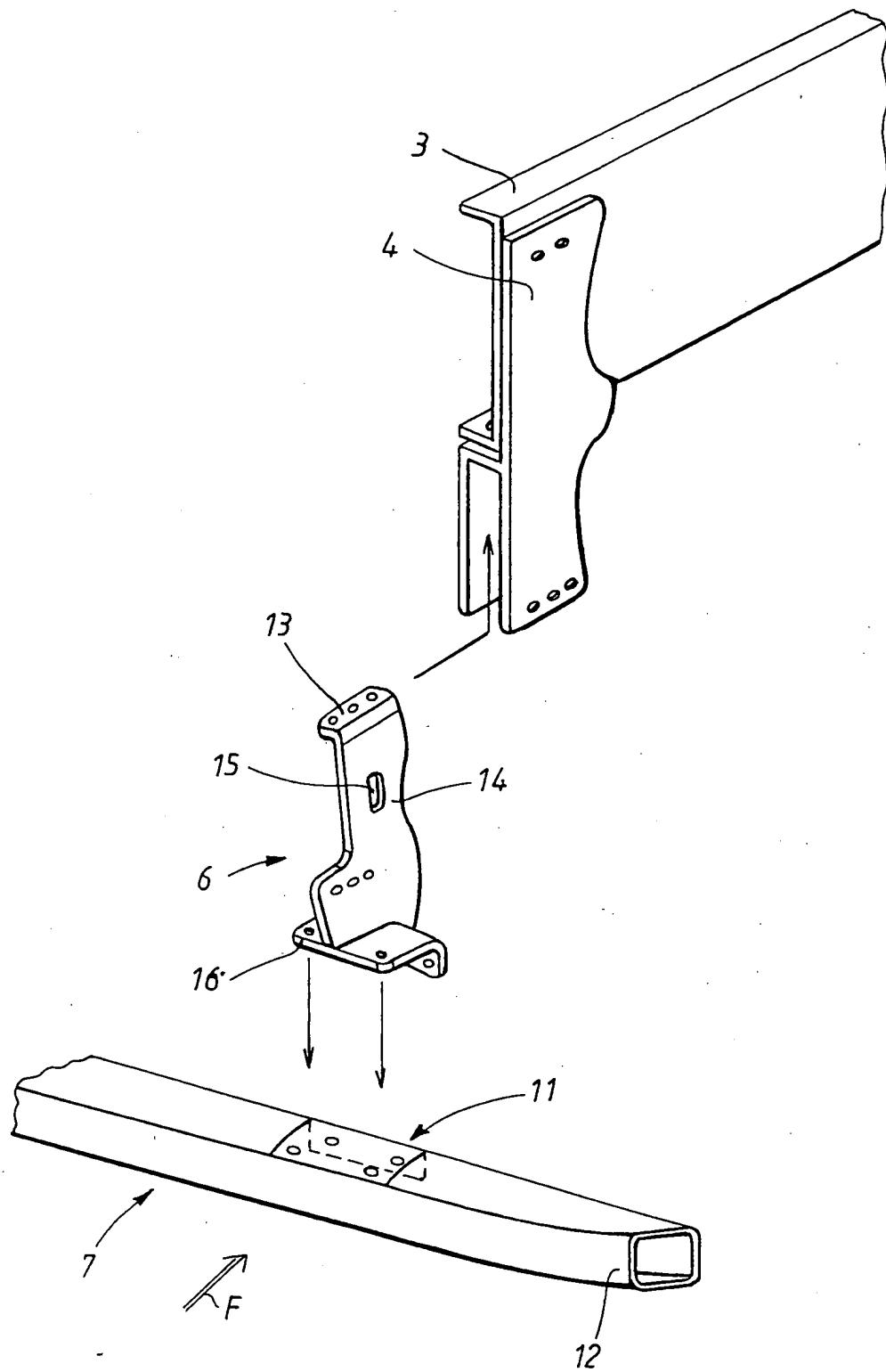
15 8. Device according to claim 7, characterized in that said counteracting element (9) consists of an existing spring attachment (9) in the vehicle (1).

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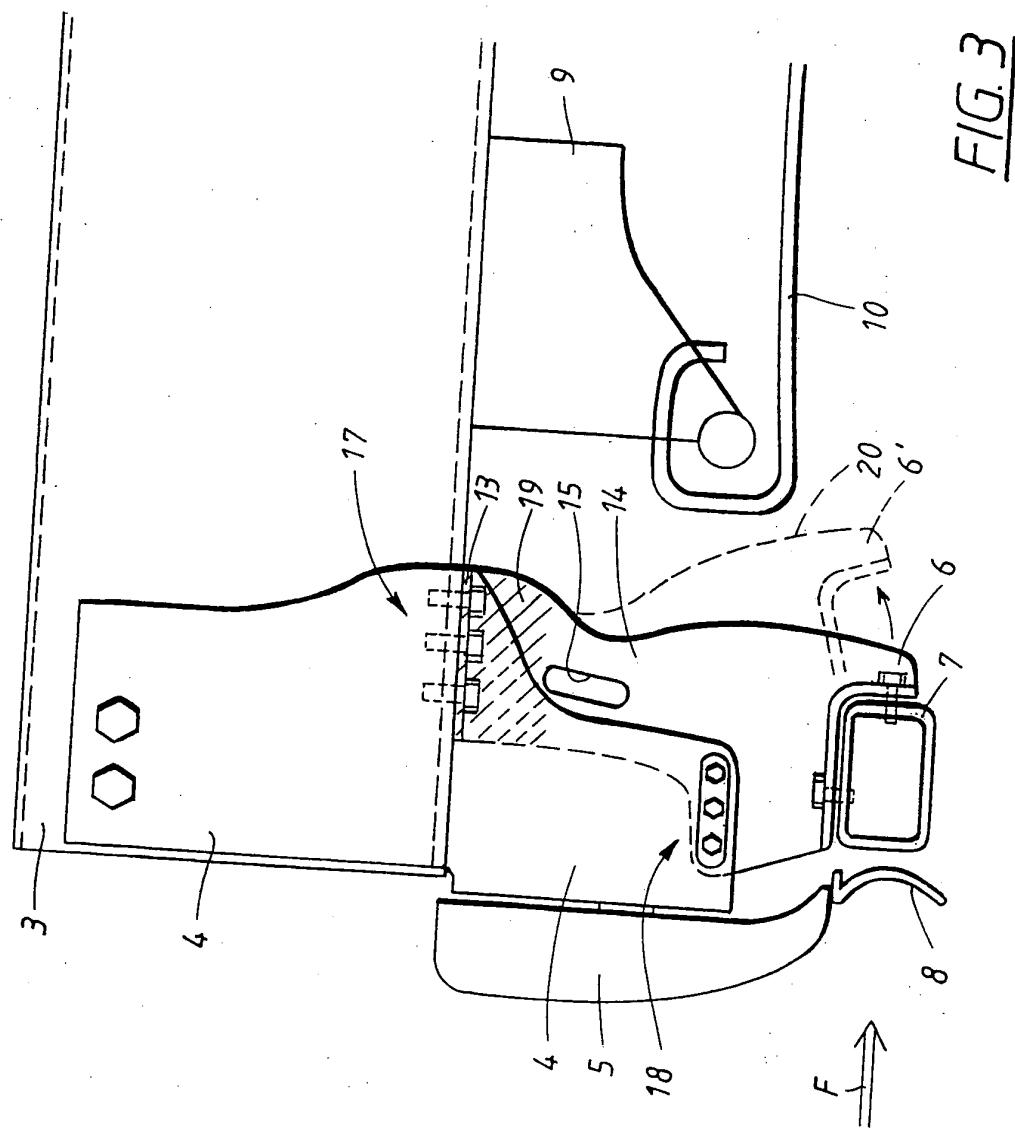


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FIG. 2

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 98/00473

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>		
<b>IPC6: B60R 19/56</b> According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols)		
<b>IPC6: B60R</b> Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched <b>SE,DK,FI,NO classes as above</b>		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	DE 4206022 A1 (MAN NUTZFAHRZEUGE AG), 2 Sept 1993 (02.09.93), abstract	7
A	--	1,3
Y	DE 2438828 C2 (QUINTON HAZELL LTD), 7 May 1987 (07.05.87), column 3, line 31 - line 36, figure a, claims 1-3	7
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<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
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International application No.  
PCT/SE 98/00473

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Y 2095630 A (LOSTOCK HALL FABRICATION LIMITED), 6 October 1982 (06.10.82), page 3, line 25	8
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**INTERNATIONAL SEARCH REPORT**

Information on patent family members

09/06/98

International application No.

PCT/SE 98/00473

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